Effect Of Lysimetric Treated Effluent On Seed Germination, Radicle Length and Plumule Length Of Wheat Plants

[1]Avnish Chauhan and [2]Namita Tewari

[1]Department of Zoology and Environmental Sciences, Gurukula Kangri University, Haridwar, 249404, Uttarakhand, India;

[2] Department of Environmental Science, Uttaranchal College of Science and Technology, Dehradun, Uttarakhand, India; E-mail: avnishchauhan_in@yahoo.com

Abstract: The lysimetric land treated of the distillery spent wash employing in different soil column height with different soil texture in combination was assessed in terms of reduction in pH, EC, total solids, total dissolved solids, COD, colour unit (CU), Na, P, K of the effluent. The distillery spent wash was treated at two different concentrations viz., 50%, and 100% for 60 days against the soil column height (CH) of 20, 40 and 100 cm with soil texture ST_1 (normal soil), ST_2 (soil + sand in 50% ratio) and ST_3 (normal soil). Maximum reduction in all parameters was observed in case of 50% spent wash with 100 cm CH and ST_3. Whereas minimum reduction in case of 100% spent wash with 20 cm CH and ST_1. Seed germination, seedling growth, radicle, plumule length and seed vigour index (SVI) was increased maximum in 50% diluted spent wash treated with 100 cm CH and ST_3, while minimum in 100% spent wash ST_1 treated in 20 cm CH and ST_1. The results depicted that land treatment can be a suitable method for distillery effluent treatment as its costs very low and reduces pollution load substantially. The treated effluent also enhanced the seed germination and plant growth, depicting its suitability for crop irrigation. [New York Science Journal. 2010;3(1):14-21]. (ISSN: 1554-0200).

Keywords: Distillery spent wash, COD, seed vigour index, seed germination

Introduction

The rapid industrialization is one of the major causes of water pollution. The discharges of untreated and partially treated waste water from various industries like chemical, pesticides, fertilizer, pulp and paper and sugar etc., have polluted the aquatic bodies such as rive, pond and ditches (Chandra et al., 2004; Sahu et al., 2007; Yadav et al., 2007; Pandey, 2008). India falls amongst the first ten industrialized countries of the world. In India about two tones wastewater is discharged into aquatic bodies annually from industries (Shaffi, 1981).Rapid industrialization for sustaining economy due to unsafe disposal of industrial effluents (Singh et al 2003). In India alone, there are more than 180 distilleries, breweries and malteries established that produce a great deal of pollution load owing to its acidic, pH, high biochemical oxygen demand (BOD), chemical oxygen demand (COD) and awful color of waste water (Binkley and Wolform, 1983). India produces around 6500 million liters of alcohol by distilleries every year with an output of 130 billion liters of waste water (Joshi et al., 1994).

Distillery waste water which is characterized by high organic matter, dissolved solids, COD, low pH and dark brown color with a foul smell (Nanjundaswamy et al., 2004). Distillery waste water creates toxic conditions in the receiving streams and results in the massive destruction of aquatic flora and fauna (Lee et al., 1999: Kardirvelu et al., 2000; Kadirvelu et al., 2003: Vasanthy, 2004). Distillery effluent is a rich source of organic carbon and plant nutrients particularly potassium, sulphur and nitrogen, but at higher concentration, the ions present in effluent may have detrimental effect on metabolic functions adversely affecting seed germination and plant growth (Singh and Bahadur,1995), whereas lower concentration increased seed germination of wheat, rice, sorghum, cowpea and soybean (Mukherjee and Sahai, 1988: Pandey and Sony ,1994: Singh et al., 1995). The utilization of industrial effluent for irrigation of agricultural crops is one of the highly beneficial propositions of waste water disposal. Keeping this in view, the present investigation was undertaken to search an economic solution of the pollution abatement problems of effluent discharged from Kesar Enterprises, Baheri, Uttar Pradesh state, by using it for irrigation purpose in the form of seed germination, radical length and plumule length of wheat (*Triticum aestivum* L. var. UP 2329).

Material and Methods

Study Area

The study was conducted with effluent released from distillery unit situated at Baheri, Uttar Pradesh. The industry uses cane molasses as raw material. The effluent samples from distillery were collected monthly at the main outlet point where combined effluent from the factory is being disposed into a small channel.

Lysimetric Setup: Lysimeter consists of galvanized sheet having 0.9m x 0.9m x 1.3 m with a basement and open top. On one side, near basement there is an outlet of 5 mm diameter. There is an 8 cm diameter pipe erected as piezometer throughout the height, is attached the above cabinet, internally whose base is perforated up to 30 cm. The lysimeter was filled with soil, layer by layer in accordance with original stratification of soil profile in the region.

Experiment consisted of two effluent concentrations (50% and 100% with distilled water) for 60 days against the soil column height(cm)of 20, 40 and 100cm,with soil texture ST_1 (normal sand, ST_2 (normal soil + sand in 50% ratio and ST_3 (normal soil). Before starting the experiment, various physico-chemical parameters viz. pH, color, cod, TS, TDS, NA, K, Ca, and Mg content of raw distillery spent wash were analyzed thrice (APHA 1995).

Wheat (*Triticum aestivum* L.Var. UP-2329) was grown in lysimeters and was kept in playhouse at 30 degree Celsius (humidity 75%) with 35% reduction in natural sunlight. After one month of growth, plans were irrigated with two different concentrations (50% and 100%) of the effluent in separate lysimetric bed. After 72 hrs of irrigation the leachate was collected and all the selected parameters for effluent was analyzed to find out the best soil texture and soil column height. For germination experiments, 10 sterilized seeds of wheat were placed in sterilized Petri dishes containing filter paper. They were kept wet continuously by adding leachate from various treatment processes against distilled water. The number of germinated seeds in each Petri dish was recorded daily up to 10 days and expressed as % seed germination. At the end of germination experiments (after 10 days) vigor index (VI) was calculated according to Abdul Baki and Anderson, 1972.

$$VI = \text{Germination\%} \times \text{Seedling Growth}$$

Results

Effect of soil texture on treated of the spent wash.

It was observed from table 1 & 2 that the removal of pollutants from distillery spent wash was maximum when passed through ST_3 (i.e. normal soil) followed by ST_2 (i.e. soil mixed with sand in 1:1 ratio) and minimum in ST_1 (i.e. normal sand). Experimental results showed that after land treatment pH of spent wash increased significantly. The pH of the spent wash was found minimum in leachate collected from ST_1 on 60 day irrigation with 50% effluent and maximum in leachate collected from ST_3 on 20 day of irrigation with 100% spent wash. Colour of the spent wash was found minimum 101.00 CU in leachate collected from ST_3 on 60 day of irrigation with 50% spent wash and maximum 3792.74 CU in leachate collected from ST_1 on 20 day of irrigation with 100% spent wash. COD was found minimum 913.33 ppm in leachate collected from ST_3 on 60 day of irrigation with 50% spent wash and maximum 3436.33 ppm in leachate collected from ST_1 on 20 day of irrigation with 100% spent wash. Total solids and total dissolved solids was found minimum 1020 and 520.33 ppm respectively in leachate collected from ST_3 on 60 day of irrigation with 50% spent wash and maximum 4760 and 2617 ppm respectively in leachate collected from ST_1 on 20 day irrigation with 100% spent wash. Amount of calcium and magnesium was found minimum 48 and 8.7 ppm respectively in leachate collected from ST_3 on 60 day irrigation with 50 % spent wash and maximum 104 and 18.66 ppm respectively in leachate collected from ST_2 on 20 day irrigation with 100% spent wash. Minimum value of sodium and potassium was found in leachate collected from ST_3 on 60 day irrigation with 50% spent wash i.e. 78 and 47.33 ppm, respectively and maximum was recorded in leachate collected from ST_1 on 20 day irrigation with 100% spent wash i.e. 111.33 and 81.33 ppm, respectively.

Effect of the varied textured land treated spent wash on wheat seed germination and radicle and plumule growth

The seed germination, radicle length, plumule length and seed vigour index of wheat was found to be enhanced by treated spent wash (Table 5).Maximum seed germination was 96.66% found in leachate collected from ST_3 on 60 day irrigation with 50 % spent wash and minimum 43.33% in leachate collected from ST_1 on 20 day of irrigation with 100% spent wash. Radicle length, plumule length and seed vigour index were found maximum 5.96, 4.96 and 1055.52 cm, respectively, in leachate collected from ST_3 on 60 day irrigation with 50 % spent wash and minimum 3.96, 4.06 and 347.50 cm, respectively, in ST_1 on 20 day irrigation with 100% spent wash. Percent increase in all these parameters was maximum in ST_3 irrigated with 50% spent wash on 60 day.

Effect of soil column height on treatment of the spent wash

Experimental results showed (Table 3 & 4) that pollutants of distillery spent wash efficiently removed through land treatment employing three soil column heights. Among three column height, CH_3 (i.e. 100 cm column height) reduced most of the selected parameters of spent wash efficiently followed by CH_2 (40 cm column height) and CH_1 (20 cm column height). It was observed from that the pH of spent wash increased when passed through varied column height of the soil. COD was found lowest in leachate collected from CH_3 on 60 day irrigation with 50% spent wash i.e. 1132 ppm and highest in leachate collected from CH_1 on 20 day irrigation with 100% spent wash i.e. 3280 ppm. The value of total solids and total dissolved solids were found minimum 955.48 and 338.45 ppm respectively in leachate collected from CH_3 on 60 day of irrigation with 50% spent wash and maximum 2683.33 and 1822.66 ppm, respectively, in leachate collected from CH_1 on 20 day of irrigation with 100% spent wash. Amount of calcium, magnesium, sodium and potassium were found minimum in leachate collected from CH_3 on 60 day of irrigation with 50% spent wash i.e. 48.00, 7.80 , 73.60 and 39.60 ppm, respectively, and maximum in leachate collected from CH_1 on 20 day of irrigation with 100% spent wash, i.e. 96.33 , 16.10, 124.00 and 65.66 ppm, respectively.

Effect of land treated spent wash irrigation on wheat seed germination and radicle and plumule growth.

It was observed from Table 6 that the seed germination, radicle length, plumule length and seed vigour index of wheat were enhanced by treated spent wash irrigation. Seed germination was found maximum 96.66% when soaked with leachate collected from CH_3 on 60 day irrigation with 50% spent wash and minimum 46.66% in leachate collected from CH_1 on 20 day irrigation with 100% spent wash. Radicle length, plumule length and seed vigour index were found maximum 5.96, 5.46 and 1103.85 cm, respectively in CH_3 when irrigated with 50% spent wash on 60 day and minimum in CH_1 when irrigated with 100% spent wash on 20 day i.e. 3.3, 2.72 and 280.89 cm, respectively.

Table1: Physicochemical Characteristics of 50% Distillery Spent Wash Treated With Different Soil Textures

Parameters	**Untreated effluent**	**Irrigation Period**								
		20 days			**40 days**			**60 days**		
		ST_1	ST_2	ST_3	ST_1	ST_2	ST_3	ST_1	ST_2	ST_3
pH	4.36 ±0.05	6.51 ±0.01	6.51 ±0.01	6.62 ±0.07	6.45 ±0.01	6.60 ±0.01	6.52 ±0.28	6.20 ±0.01	6.60 ±0.27	6.49 ±0.01
Colour	2837.09 ±8.80	426.03 ±2.49	546.13 ±2.49	159.58 ±1.91	329.07 ±1.44	320.45 ±2.88	107.23 ±0.57	315.63 ±3.56	295.69 ±14.4	101.00 ±1.44
COD	3850.00 ±21.60	2146.66 ±23.72	2433.33 ±19.62	199.66 ±7.20	1776.66 ±11.86	1276.66 ±9.81	1313.33 ±28.80	1176.66 ±11.86	960.00 ±24.9	913.33 ±19.62
TS	2890.00 ±12.47	1479.00 ±1.69	1423.33 ±1.44	1141.00 ±1.69	1344.33 ±1.78	1245.33 ±2.88	1065.33 ±2.88	1179.66 ±2.12	1141.66 ±2.22	1020.00 ±14.43
TDS	2188.33 ±11.86	760.66 ±1.44	720.00 ±0.94	580.00 ±0.94	579.66 ±1.18	639.00 ±1.69	542.00 ±1.88	554.00 ±0.94	522.66 ±1.18	520.33 ±0.72
Ca	98.93 ±0.47	96.33 ±0.72	94.33 ±1.44	62.33 ±0.72	79.66 ±0.72	76.66 ±1.18	54.00 ±1.88	77.00 ±0.47	69.66 ±0.98	48.00 ±0.94

Mg	17.83 ±0.36	16.5 ±0.62	14.16 ±0.49	13.00 ±0.23	15.16 ±0.59	13.03 ±0.42	12.53 ±0.28	9.13 ±0.34	8.80 ±0.20	8.70 ±0.12
Na	112.33 ±1.18	109.66 ±0.72	104.33 ±0.98	94.00 ±1.88	92.33 ±1.18	97.33 ±0.54	83.33 ±0.98	84.33 ±1.65	80.00 ±1.24	78.00 ±4.10
K	71.33 ±1.50	66.16 ±0.36	55.33 ±1.65	50.33 ±1.18	63.26 ±0.57	53.13 ±0.28	49.90 ±0.28	61.10 ±0.42	52.86 ±0.45	47.53 ±0.21

ST_1= Normal Sand, ST_2= Sand mixed with soil (50:50), ST_3= Normal Soil

Table 2: Physicochemical Characteristics of 100% Distillery Spent Wash Treated With Different Soil Textures

Parameters	Untreated effluent	Irrigation Period								
		20 days			40 days			60 days		
		ST_1	ST_2	ST_3	ST_1	ST_2	ST_3	ST_1	ST_2	ST_3
pH	4.48 ±0.08	6.53 ±0.01	6.55 ±0.01	6.90 ±0.10	6.22 ±0.11	6.56 ±0.08	6.55 ±0.26	6.56 ±0.26	6.53 ±0.01	6.42 ±0.15
Colour	5837.40 ±3.03	3792.74 ±26.05	3024.54 ±2.46	1638.90 ±1.88	1578 ±11.16	1571.63 ±2.32	1352.00 ±2.32	1638.96 ±54.29	1352 ±8.99	1012.33 ±8.99
COD	3880.00 ±37.71	3436.33 ±25.96	3226.66 ±14.40	2633.33 ±98.13	2953.00 ±30.30	2786.66 ±5.44	2453.33 ±23.72	2813.33 ±46.50	2600 ±9.40	1760.00 ±18.55
TS	4950.33 ±0.62	4760.00 ±1.88	2364.32 ±2.51	2142.66 ±2.49	2358.66 ±1.96	2214 ±2.37	2068.66 ±1.44	2236.66 ±1.96	3904.00 ±2.37	1964.33 ±3.39
TDS	2760.33 ±73.78	2617.00 ±1.69	1759.33 ±1.44	1561.33 ±1.96	2039.33 ±1.44	1441.33 ±2.37	1555.33 ±1.90	1857.33 ±3.03	1622.00 ±1.44	960.00 ±1.88
Ca	115.00 ±2.62	104.00 ±0.94	100.66 ±1.96	63.33 ±0.98	96.00 ±0.94	97.66 ±0.72	61.66 ±0.98	96.00 ±0.94	86.00 ±0.94	62.00 ±1.69
Mg	20.90 ±0.45	18.66 ±1.45	18.53 ±0.72	17.00 ±0.23	16.33 ±0.49	15.33 ±0.59	14.70 ±0.38	17.33 ±0.26	17.30 ±0.32	15.00 ±0.23
Na	134.33 ±2.76	111.33 ±1.44	107.66 ±3.95	105.33 ±0.72	107.33 ±1.44	101.00 ±1.24	106.00 ±0.47	95.33 ±1.18	103.00 ±0.47	93.33 ±1.78
K	85.83 ±0.49	81.33 ±1.96	71.00 ±2.05	62.66 ±1.18	78.33 ±1.18	71.66 ±1.18	58.66 ±0.98	75.00 ±0.47	64.16 ±0.49	58.00 ±0.90

ST_1= Normal Sand, ST_2= Sand mixed with soil (50:50), ST_3= Normal Soil

Table 3: Physicochemical Characteristics of 50% Distillery Spent Wash Treated With Different Soil Column Height

Parameters	Untreated effluent	Irrigation Period								
		20 days			40 days			60 days		
		CH_1	CH_2	CH_3	CH_1	CH_2	CH_3	CH_1	CH_2	CH_3
pH	4.60 ±0.05	6.60 ±0.40	6.50 ±0.04	6.43 ± 0.07	6.58 ±0.01	6.5 ±0.02	6.6 ±0.03	6.41 ±0.02	6.56 ±0.03	6.60 ±0.06
Colour	2837.09 ±2.88	1255.65 ±1.96	1064.72 ±0.72	984.98 ±0.98	1866.9 6 ±2.3	981.78 ±2.32	864.32 ±2.08	1848.5 2 ±0.54	968.00 ±0.06	852.34 ±0.80
COD	3850.00 ±21.60	2676.66 ±11.86	1773.33 ±14.40	1300.0 0 ±24.94	1576.6 6 ±9.81	1170 ±12.47	11148.5 2 ±16.08	1562.3 4 ±8.70	1166.4 2 ±16.84	1132.8 4 ±15.45
TS	2890.00 ±1.96	1445.33 ±2.38	1044.66 ±1.44	979.33 ±1.44	1361.6 6 ±2.22	989.34 ±0.62	968.24 ±1.68	1352.3 8 ±3.20	975.68 ±1.44	955.48 ±1.68

TDS	2183.33 ±2.13	1020.66 ±0.54	622.00 ±1.86	350.00 ±2.49	1019.33 ±1.44	616.54 ±2.46	348.20 ±1.44	989.34 ±1.44	608.26 ±8.20	338.45 ±2.42
Ca	98.93 ±0.03	96.33 ±0.47	94.33 ±0.98	64.33 ±1.44	78.66 ±0.86	76.66 ±0.24	54.00 ±1.24	76.66 ±0.76	68.66 ±0.64	48.00 ±0.70
Mg	17.83 ±0.41	11.20 ±0.28	9.46 ±0.55	8.03 ±0.35	9.30 ±0.40	8.70 ±0.50	8.00 ±0.30	9.00 ±0.68	8.10 ±0.70	7.80 ±0.50
Na	112.33 ±0.72	96.66 ±0.72	87.00 ±0.46	77.33 ±0.54	92.30 ±0.80	88.45 ±3.20	75.23 ±0.80	89.20 ±2.50	81.20 ±2.90	73.60 ±0.50
K	71.33 ±0.80	64.40 ±0.34	56.66 ±0.72	38.26 ±0.61	62.10 ±1.10	45.10 ±0.60	40.30 ±0.40	55.40 ±0.80	44.40 ±0.70	39.60 ±0.20

CH_1 = 20 cm column height, CH_2 = 40 cm column height, CH_3 = 100 cm column height

Table 4: Physicochemical Characteristics of 100% Distillery Spent Wash Treated With Different Soil Column Height

Parameters	Untreated effluent	Irrigation Period								
		20 days			40 days			60 days		
		CH_1	CH_2	CH_3	CH_1	CH_2	CH_3	CH_1	CH_2	CH_3
pH	4.48 ±0.04	6.65 ±0.04	6.53 ±0.09	6.46 ±0.09	6.49 ±0.24	6.50 ±0.04	6.40 ±0.12	6.53 ±0.01	6.40 ±0.10	6.50 ±0.01
Colour	5837.09 ±8.80	5220.24 ±2.76	3029.84 ±3.56	2046.24 ±2.86	3282.4 ±28.80	2968.20 ±2.05	1998.30 ±0.94	2046.24 ±2.80	2842.4 ±2.00	1986.40 ±0.90
COD	3880.00 ±15.15	3280.00 ±9.42	2856.66 ±9.80	2413.33 ±19.62	2840.00 ±36.81	1476.66 ±11.86	1376.66 ±31.38	2642.12 ±12.20	1402.34 ±19.62	1220.66 ±21.30
TS	4950.33 ±16.55	2683.66 ±2.20	2025.33 ±2.88	2016.33 ±2.88	2275.33 ±27.23	2008.30 ±2.49	1997.40 ±1.44	2025.33 ±33.20	1984.30 ±1.40	1980.60 ±2.33
TDS	2760.00 ±4.02	1822.66 ±1.44	1632.33 ±3.03	1078.00 ±2.49	1453.33 ±10.08	753.33 ±1.96	643.33 ±1.08	1344.33 ±1.78	739.00 ±1.69	625.66 ±2.76
Ca	115.00 ±0.59	96.33 ±0.94	94.33 ±1.24	62.33 ±0.47	79.66 ±0.86	75.50 ±0.72	60.00 ±1.62	75.50 ±1.65	69.66 ±1.62	58.00 ±2.76
Mg	20.90 ±0.49	16.10 ±0.26	15.13 ±0.28	14.23 ±0.41	16.00 ±0.60	15.10 ±0.70	14.00 ±0.20	14.60 ±0.20	14.10 ±0.20	13.50 ±0.70
Na	134.33 ±1.41	124.00 ±0.94	111.66 ±1.51	111.00 ±2.05	109.66 ±0.72	105.28 ±2.34	101.32 ±1.68	97.33 ±0.54	92.33 ±1.18	88.64 ±2.33
K	85.83 ±0.98	65.66 ±1.50	61.23 ±0.55	56.33 ±0.98	65.06 ±0.80	58.03 ±0.80	52.66 ±0.80	51.43 ±1.20	48.10 ±1.30	48.33 ±0.70

CH_1 = 20 cm column height, CH_2 = 40 cm column height, CH_3 = 100 cm column

Table 5: Effect of Land Treated Varied Concentration of Distillery Spent Wash on Wheat Seed Germination, Radicle Length, Plumule Length and SVI

Irrigation periods	**Treatments**	**Seed germination**	**Radicle length(cm)**	**Plumule length**	**SVI**
	Untreated 50%	36.66 ±2.72	4.03±0.04	2.90±0.11	254.05
20 DAYS	ST_1	63.33 ±2.70	4.71±0.05	4.23±0.11	566.17
	ST_2	83.33 ± 2.72	5.02±0.06	4.26±0.11	773.30
	ST_3	90.00± 4.71	5.43±0.01	4.46±0.05	890.10
40 DAYS	ST_1	73.33±2.70	5.00±0.09	4.53±0.13	698.83
	ST_2	86.66±2.70	5.30±0.12	4.33±0.19	834.53

	ST_3	96.66±2.72	5.83±0.07	4.66±0.28	1013.96
60 DAYS	ST_1	76.66±2.70	5.56±0.09	4.26±0.07	752.80
	ST_2	86.66±2.70	5.66±0.07	4.26±0.07	902.99
	ST_3	96.66±2.72	5.96±0.07	4.96±0.07	1055.52
	Untreated 100%	26.66±2.72	3.83±0.21	2.96±0.17	181.02
20 DAYS	ST_1	43.33±2.70	3.96±0.19	4.06±0.12	347.50
	ST_2	50.66±2.74	4.13±0.20	4.23±0.09	923.51
	ST_3	56.66±2.72	4.66±0.19	4.33±0.19	509.37
40 DAYS	ST_1	46.66±2.70	4.24±0.23	4.06±0.15	387.27
	ST_2	53.33±2.74	4.50±0.13	4.06±0.11	456.50
	ST_3	63.33±2.70	5.20±0.04	4.53±0.11	616.20
60 DAYS	ST_1	50.00±2.74	4.90±0.16	4.56±0.19	473.0
	ST_2	60.66±4.71	5.16±0.09	4.60±0.16	592.04
	ST_3	66.66±4.71	5.36±0.19	4.80±0.04	677.28

ST_1= Normal Sand, ST_2= Sand mixed with soil (50:50), ST_3= Normal Soil

Table 6: Effect of Land Treated Varied Concentration of Distillery Spent Wash on Wheat Seed Germination, Radicle Length, Plumule Length and SVI

Irrigation periods	Treatments	Seed germination	Radicle length	Plumule length	SVI
	Untreated 50%	43.33±2.70	2.96± 0.11	2.90± 0.11	253.91
20 DAYS	CH_1	63.33±2.72	3.86±0.12	3.46±0.14	463.35
	CH_2	73.33±2.74	4.13±0.20	3.53±0.19	561.70
	CH_3	90.00±4.71	4.83±0.11	3.86±0.12	782.10
40 DAYS	CH_1	70.00±4.71	4.50±0.09	3.80±0.09	581.00
	CH_2	76.66±2.70	4.66±0.19	4.48±0.24	700.67
	CH_3	93.33±2.74	5.46±0.26	4.96±1.12	872.49
60 DAYS	CH_1	83.33±2.72	4.90±0.16	4.46±0.19	779.96
	CH_2	86.66±4.71	5.16±0.06	5.00±0.26	880.46
	CH_3	96.66±2.70	5.96±0.09	5.46±0.12	1103.85
	Untreated 100%	36.66±2.70	2.62±1.12	2.50±0.16	187.69
20 DAYS	CH_1	46.66±5.44	3.30± 0.14	2.72±0.11	280.89
	CH_2	53.33±2.71	3.42±0.27	2.83±0.19	333.31
	CH_3	63.33±2.40	3.83±0.19	3.13±0.16	440.77
40 DAYS	CH_1	53.33±2.70	3.86±0.12	3.23±0.16	378.10
	CH_2	56.66±4.12	4.00±0.23	3.63±0.21	434.31
	CH_3	70.00±4.70	4.32±0.16	3.90±0.61	575.50
60 DAYS	CH_1	60.60±4.71	4.18±0.36	3.43±0.12	461.16
	CH_2	66.66±2.72	4.43±0.07	4.13±0.20	570.60
	CH_3	70.33±4.70	4.80±0.06	4.33±0.12	642.11

CH_1 = 20 cm column height, CH_2 = 40 cm column height, CH_3 = 100 cm column

Discussion

Land treatment by using effluent or waste water as irrigation provides one of the best option for reducing the disposal problem of hazardous effluent and enhancing the productivity of crops owing to the use of chemicals adhered in effluent as nutrients (Sims and Riddell, 1998; Roygard et al., 1999). During land treatment soil physical (texture, structure, bulk density, infiltration, permeability, pore space, water holding capacity etc.), chemical (sorption, precipitation, nutrient availability etc.) and biological (microbial activity) properties and processes are mainly responsible for reducing the pollution load from the waste water when passed through the land (Lindsay , 1979). Distillery spent wash in this study was dark brown in colour, low pH with higher COD, total solids and total dissolved solids. This is in consonance with the studies of Chhonkar et al . (2000) and Pandey et al., (1994). Colour of spent wash may be due to molassess used for fermentation, anthrocyanins and tannins, when such spent wash passed through the soil column. These compounds are absorbed on soil particles and reduced the colour, COD and organic carbon content of spent wash. The amount of total solids and total dissolved solids are reduced significantly by land treatment because soil works as a sieve. Lighat and Prasher (1996) also reported that by land treatment, pollution load such as solids of the effluent was reduced significantly. Maximum reduction in pollution of spent wash was found with normal soil followed by soil mixed with 50% sand and minimum in sand .This is due to the soil texture which influenced the soil's physical properties (soil structure, bulk density, pore space etc.), chemical properties (sorption, precipitation, complex formation etc.) and biological properties and processes (water holding capacity, microbial activity etc.) as has been reported by Reddy and Reddi (1999). Sandy soils are porous, have high infiltration rates and retain little water. In contrast, soils have low infiltration rates, retain much water and may be poorly drained. So reduction in pollution load of spent wash was found more by normal soil. Reduction in pollution load of spent wash was found maximum in 100 cm column height followed by 40 cm height and 20 cm column height. This is due to the fact that in high soil column height spent wash took more time, whilst a low column height spent wash passed easily and took less time to percolate and remain little contact with the soil. Thus greater column height is more efficient for removal of pollutants from spent wash. Avnimelech and Ravesh (1976) also reported similar observation while studying the soil nitrate leakage from soils of varied texture and column height. The changed status of spent wash owing to land treatment has brought significant changes in wheat germination and seedling growth when soaked with it. It was observed that seed germination was more at 50% spent wash irrigation over control (table). This is due to the fact that the reduction in pollution load is maximum in irrigation with 50% spent wash showed the similarity with observations of Singh et al., (1995) and Pandey et al., (1994). Although their was conspicuous reduction in pollution load of 100% spent wash due to land treatment but its physico-chemical characteristics were too high and thus enhanced the seed germination and growth in wheat moderately. In contrast, 50% effluent treated through land proved best for seed germination and radicle and plumule growth in wheat. Pandey (2008) also observed that low effluent concentration (50%) shows the low inhibitory effects and indicates that various metallic and nonmetallic elements act as nutrients but show toxic effects in plants at higher effluent concentration (100%). Growth characteristics such as plant heath (i.e. radicle length and plumule lengths) and seed vigour index increased with 50% effluent irrigation and decreased with 100% (undiluted) effluent irrigation at all soil column height reported by Singh et al., 2003. Similar observation has been reported by Mishra and Behra, 1991 and Singh et al., 2002.

Conclusion

The study also revealed a very significant and pertinent observation that treatment of effluent through land reduced pollution load significantly and avoid further contamination/ pollution of deeply sat ground water in the region. As such, the substantiality of such disposal system reserve further research with specific soil and crop choices (fast growing and higher tonnage per unit time and unit area, quick rejuvenation after harvest) along with management technologies (seasonal flooding and improved drainage) to combat the ill effect on the environment without deteriorating it any more.

References:

1. APHA. *Standard methods from the examination of water and waste water*. A. M. Publ. Health Assoc. New York 19th (Ed.) 1995.
2. Avnimelech Y, Raveh J. Nitrate leakage from soils dirrening in texture and nitrogen load. J. Environment Quality 1976; 5: 79-82.
3. Baki A, Anderson JD. Vigour determination soyabean seed by multiple criteria. *Crop. Sci*. 1973:3.
4. Binkley WA, Wolform ML. Composition of cane final molasses. In: Advances in carbohydrate chemists. Ed. C.S. Hundror and M.L. Wolform Academic Press. Inc. Publ., New York, USA. 1983: 8-29.
5. Chandra R, Kumar K, and Singh L. Impact of an aerobically treated and untreated (raw) distillery effluent irrigation on soil microflora, growth, total

chlorophyll and protein contents of *Phaseolus aureus* L. *J. Environ. Biol.* 2004; 25(4):381-385.
6. Chhonkar PK, Datta SP, Joshi HC, Pathak H. Impact of industrial effluents on soil health and agriculture- Indian experience: part I-distillery and paper mill effluent. *Journal of Scientific and Industrial Research* 2000; 59(5):350-361.
7. Joshi RD, Kapandnis BP. Pretreatment of distillery spent wash for bio-envirchment with dinitrogen fixers. *Biol. Ind.* 1992; 3: 65-70.
8. Kadirvelu K, Brasquet C, Cloirec P. Removal of Cu(II), Pb(II) and Ni (II) by adsorption onto activated carbon cloths. *Langmuir* 2000; 16: 8404-8409.
9. Kadirvelu K, Kavipriya M, Karthika C, Radhika M, Vennilamanni N, Pattabhi S. Utilization of various agricultural wastes for activated carbon preparation and application for the removal of dyes and metal ions from aqueous solutions. *Bioresource Technology* 2003; 87: 129-132.
10. Lee CK, Low KS, Gan PY. Removal of some organic dyes by acid treat spent bleaching earth. *Environ. Technol.* 1999; 20: 99-104.
11. Lighat A, Prasher SO. A lysimeters study of grass cover and water table depth effects on pesticides residues in drainage water. *ASAE* 1996; 39(5): 1731-1738.
12. Lindsay, WL. Chemical equilibria in soils. WileSy Interscience, New York. 1979.
13. Mukherjee U Sahai R. Effects of distillery waste on seed germination and early seedling growth of soybean, cowpea, rice and sorghum. *Seed Res.* 1988; 16(2): 173-177.
14. Nanjundaswamy C, Jain N, Kumar P, Srivastava AK. Biodegradation of predigested distillery waste water by aerobic bacterial stress. *J. Indian Assoc Environ. Manage*. 1998; 18: 658-661.
15. Pandey DK, Prafulla S, Soni P. Distillery effluent a potential resource for irrigating forest seed beds. *Ambio.*1994;23(4-5):267-8.
16. Pandey SN. Growth and biochemical changes in pulse seedlings irrigated with effluent from electroplating industry. *J. Appl. Biosci.* 2008 34(1): 79-82.
17. Reddy TY and Reddi GHS. Soil environment and its modification. Principles of Agronomy. Kalyani Publishers, New Delhi 1999.
18. Roygard JKF, Green SR, Clothier BE, Sims REH, Bolan NS. Short rotation forestry for land treatment, Australia. *Journal of Soil Research* 1999; 37(5): 983-991.
19. Sahu RK, Katiyar S, Tiwari J, Kiskum GC. Assessment of drain water receiving effluent from tanneries and its impact on soil and plants with particular emphasis on bioaccumulation of heavy metals. *J. Environ. Biol.* 2007; 28(3): 685-690.
20. Shaffi SA. Mercuric toxicity, biochemical and physiological alterations in nine freshwater. Teleosts. 1981; 8: 187-194.
21. Sims REH, Riddell BD. Sustainable production of short rotation forest biomass crops using aquerous waste management systems. *Biomass and Bioenergy* 1998;15(1):75-81.
22. Singh Y, Bahadur R Bahadur R. Germination of field crop seeds in distillery effluent. *Indian Journal of Ecology*. 1995; 22(2): 82-85.
23. Singh A, Agrwal SB, Rai JNP. Effluent of paper industry effluent on growth, yield and nutrient quality of wheat plants at various soil column height. *Environmental Biology and Conservation*, 2003; 8: 50-56.
24. Vasanthy M, Thamaraiselvi C, Velmurugan R. Physico-chemical charactyerizatiion of untreated and anaerobically treater distillery effluent. *J.Ind.Pollut. Cont.* 2004;20:125-130.
25. Yadav A, Nerliya S, Gopesh A. Acute toxicity levels and ethological responses of Channa striatus to fertilizer industrial wastewater. *J. Environ. Biol.* 2007; 28(2): 159-162.

7/12/2009